United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

FY 2006

Surveillance, Monitoring and Research on Emerging Zoonotic Diseases

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National Wildlife Research Center Scientists Monitor and Assess the Roles of Wildlife in the Transmission and Spread of Emerging Infectious Diseases

Wildlife Services' (WS) National Wildlife Research Center (NWRC) is the only Federal research organization devoted exclusively to resolving conflicts between people and wildlife through the development of effective, selective, and acceptable methods, tools, and techniques.

Considerable concern exists around the world about recent emerging infectious diseases. Seventy-five percent of these emerging infectious diseases are zoonotic, meaning they are naturally transmitted between wildlife species and humans. Some zoonotic diseases carried by wildlife also can be transmitted to economically important domestic animals, such as West Nile virus (WNV) to horses, and avian influenza (AI) to poultry. Thus, wildlife populations often play a key role in many diseases that directly impact humans and agriculture. NWRC is at the forefront in the monitoring, surveillance and research of many of these diseases.

AI viruses are found naturally in waterfowl and other wild bird species. There are 144 known subtypes of AI but few of these subtypes cause serious disease in birds. However, mutation of the virus can lead to infection of new wildlife species, domestic livestock (primarily poultry), and humans. These changes can result in AI strains that are highly pathogenic. Recently, highly pathogenic avian influenza (HPAI) has spread from Asia across the Eastern Hemisphere and has caused considerable mortality in domestic poultry, as well as some human deaths. The rapid geographic expansion of HPAI has prompted early detection and monitoring plans in the United States and increased research into how the virus may be spread through wildlife populations.

Another disease of concern is WNV which first appeared in North America in 1999 and has since spread across the United States. The virus is spread through the bite of a mosquito. Birds are the primary host, but mammals, including humans, can also become infected. WNV causes illness and mortality in wild birds, some wild mammals, domestic horses and humans. For example, 2,947 people and 604 horses in Colorado were infected by WNV in 2003; 622 people were hospitalized and 63 people died, costing $22.4 million in Colorado for that year alone. WNV continues to be a pathogen of concern to human health. Study of the ecology of WNV can also help the United States prepare for potential future disease introductions.

Major Research Accomplishments:

- WS developed sampling and laboratory methodologies and processed approximately 50,000 environmental samples in support of the national avian influenza monitoring effort.
- WS conducted research on the roles of wildlife in harboring and transmitting avian influenza to domestic animals and humans.
- WS is developing large-scale spatial risk assessment models to predict routes of introduction and spread of avian influenza in the United States.
- WS evaluated the role of wildlife as hosts for West Nile virus.
- WS continues to develop early-warning surveillance systems for predicting West Nile virus activity.

Applying Science and Expertise to Wildlife Challenges

Monitoring Highly-pathogenic H5N1 Avian Influenza in the United States–One potential route for introduction of HPAI into the United States includes migration of in-

fected wild birds, including ducks, geese and shorebirds. Some waterfowl species may be only mildly affected by HPAI which makes them ideal dispersers of the virus over long distances. As part of the U.S. Interagency Strategic Plan for the Early Detection of Highly Pathogenic H5N1 Avian Influenza in Wild Migratory Birds, the NWRC was responsible for analyzing more than 50,000 fecal samples collected from wild birds. NWRC scientists also convened a committee of scientists to design a nation-wide monitoring program for the collection of environmental samples (both fecal and water), developed field sampling methods and guidelines, tested and evaluated various methods for collecting water samples from areas actively used by waterfowl, and developed laboratory assays to detect AI in fecal samples.

Potential Transmission and Spread of Avian Influenza from Waterfowl to Agriculture and Human Populations—In collaboration with other scientists, NWRC scientists are developing risk assessment models to identify potential routes of introduction and subsequent spread of AI by waterfowl in the United States. These models couple spatially explicit risk assessment models with field and laboratory data from AI samples collected from wild birds, band recovery data from waterfowl, the distribution of poultry operations, and genetic sequencing of detected AI subtypes in collected samples. Coupling the genetic information with band recovery data provides information about migratory patterns and gives insight on where birds exposed to specific AI virus genotypes originated, where they moved to, and how they may further spread AI by mixing with other migratory populations. This allows scientists to identify areas where highly pathogenic strains of AI may be introduced into the United States and where they may subsequently spread in relation to domestic poultry operations and human populations.

Role of Feral Pigs and Wildlife in the Transmission and Spread of Avian Influenza—NWRC scientists are examining whether feral pigs, in association with natural wildlife reservoirs, such as waterfowl, pose risks for the development of virulent AI strains. Other avian and mammalian wildlife species, such as raccoons, may also carry and transmit AI from wildlife systems to agricultural and human systems. Because little is known about AI in other wildlife species, NWRC scientists have begun studies to determine whether wildlife species act as hosts for AI, whether they can be infected from water sources contaminated with AI by infected waterfowl, and whether they can transmit the virus to other wildlife species, livestock or poultry.

Development of New Methods to Monitor Avian Influenza in the Environment—Although AI can survive for extended periods in water (30-200 days), dilution of the virus in water beyond detectable limits may prevent the detection of the virus using current sampling methods. One alternative for sampling water is to use aquatic organisms, such as freshwater mollusks (mussels and clams), that naturally concentrate virus from the surrounding water. Mollusks accumulate a variety of viruses and can concentrate some virus 100-fold from the surrounding water in their tissues. NWRC scientists are investigating whether freshwater mollusks can concentrate AI virus from surrounding water and be a useful tool for monitoring the presence of AI in water. In addition, NWRC scientists are developing more sensitive laboratory assays to detect AI in water, fecal samples and tissues. These efforts, if successful, will significantly reduce field surveillance costs and allow for more accurate and thorough risk assessments.

Surveillance Studies for West Nile Virus Activity in a Variety of Hosts—Collaborative studies on the host range and exposure rates of WNV continue to be performed in a variety of species across the United States. These studies include evaluating: 1) different wild bird species as competent hosts for WNV, 2) the role of avian populations in maintenance of WNV, 3) the exposure rates to WNV in a variety of mammal species, and 4) tree squirrels as wildlife hosts for WNV, as well as indicators of local prevalence of WNV. Among mammal species, prevalence of WNV antibodies ranged from 0% to 50.0%, with tree squirrels (Sciurus spp.) exhibiting high seroprevalence rates (49.1%). Experimental infections of tree squirrels indicated that they could serve as amplifying hosts in nature for WNV and could contribute to WNV transmission. Thus, squirrels may be good indicator species of WNV activity in an area. Sampling squirrels during the winter months may allow for accurate predictions of where WNV will be active the following year.

Cliff Swallows as Early Indicators of West Nile Virus—Identifying and predicting the intensity of WNV activity in certain areas is crucial to the planning of disease control activities. NWRC researchers have identified a promising surveillance system in nesting cliff swallows. WNV positive ecotoparasites (swallow bugs) found in swallow nests are capable of over-wintering in the nests and can be used to indicate possible sources of future viral activity. In fact, researchers identified WNV infection in cliff swallow nestlings five weeks prior to the first human infections. The role of ectoparasites in the transmission cycle of WNV is currently being examined more closely in laboratory and field studies. Sampling cliff swallow nests is economical because swallows nest on bridges over water and the nests are easily accessible. Testing for WNV in bugs extracted from nests during the winter allows for the easy prediction of disease activity the following spring. Using this system, NWRC provides surveillance data to public health officials that aids in the targeting of areas for pesticide application to control mosquitoes.

Groups Affected By These Problems:

- Wildlife and natural resource managers
- U.S. citizens
- Livestock and poultry producers
- Farmers
- Consumers
- Public health organizations and hospitals
- Federal, State and Local governments

Major Cooperators:

- USDA/APHIS/Wildlife Services
- USDA/APHIS/Veterinary Services
- DOI/USGS/Biological Resources Division
- Colorado State University
- State Departments of Public Health
- Mississippi State University
- Berryman Institute

Selected Publications:

Clark, L.; Hall, J. S. 2006. Avian influenza in wild birds: status as reservoirs and risks posed to humans and agriculture. Ornithological Monographs 60:3-29.

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Santaella, J.; McLean, R.; Hall, J. S.; Gill, J. S.; Bowen, R. A.; Hadow, H. H.; Clark, L. 2005. West Nile virus serosurveillance in Iowa white-tailed deer (1999-2003). American Journal of Tropical Medicine & Hygiene 73:1038-1042.

Sullivan, H.; Linz, G.; Clark, L.; Salman, M. 2006. West Nile virus antibody response in Red-winged blackbirds (Agelaius phoeniceus) from North Dakota (2003-2004). Vector-borne and Zoonotic Disease 6(3):305-309.